HEMODYNAMIC EVALUATION IN SELECTION OF AMPUTATION LEVEL

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INTRODUCTION

Although the amputee and his remaining limb present many interesting and challenging problems, no detailed study exists of the progression of vascular changes in the remaining limb of the amputee. Goldner (1) in 1960 stated that the second leg of the unilateral diabetic amputee shares the fate of the first rather often and relatively soon. A somewhat similar fate can be assumed for the patient with arteriosclerotic occlusive disease who may or may not have diabetes.

Since a remaining limb of an amputee or a contralateral limb of a vascular patient will eventually manifest vascular problems, the limb or limbs should be followed and assessed until a condition is presented for an initial or second amputation.

Peripheral vascular disease in its most common form represents an insidious progressive process of arterial involvement. The exact etiology of the disease is not known. It is, however, characterized by a gradual deposition of fibrous plaques in the intima of the major arteries. The deposits thicken reducing the flow of blood through the vessels. Eventually the vessel or vessels may become stenosed with a resultant inadequate blood supply to dependent tissues, when critical stenosis is reached. Tissue function is compromised and gangrene will undoubtedly occur. As part of the search for clues and predictors related to the nature of progressive vascular changes, we are studying pulsatile blood flow waveforms (2,3) in the remaining limb of both recent and older amputees, and bilaterally in patients without amputation.

METHODS

Because of the progressive nature of peripheral vascular disease; we believe that vascular test procedures, and especially the noninvasive diagnostic and screening techniques, help to identify early changes in the vasculature and thus lead to prompt remedial action.

Vascular test procedures play an important role in: 1. determining the
degree of vascular involvement, 2. locating the possible site or sites of obstruction, 3. assessing success or failure of reconstructive vascular procedures, 4. determining the level for amputation of a limb, 5. assessing efficacy of treatment and therapy, and 6. monitoring progression of disease. It is essential that all known or suspected vascular patients have a periodic evaluation of their vascular status.

At Castle Point VAH, the Vascular Clinic has become the focal area for all activities related to preoperative and postoperative evaluations and followup testing for the vascular patient.

After an initial series of noninvasive vascular tests, all patients with indications for surgical procedures are scheduled for angiography. Patients who have received their initial series of noninvasive vascular tests are included in a vascular registry and are scheduled for continued screening tests at least three times a year. Three screening tests used routinely are: 1. Pressure Gradient Evaluation, 2. Ultrasonic Doppler Blood Velocity Analysis, and 3. Claudication Evaluation.

Following angiography, a patient may be recommended for further testing which may then be followed by lumbar sympathectomy and/or reconstructive surgery and further test procedures. Currently, in our vascular registry there are over 500 patients with varying degrees of peripheral vascular disease who are being monitored on a regular basis using noninvasive test procedures. The prevention of and the reduction of limb amputation due to peripheral vascular disease require a total program of continuing noninvasive vascular testing which is quantified wherever feasible.

Measurement techniques for the evaluation of peripheral vascular disease fall into two broad categories, i.e., the direct and the indirect. Once a patient is referred to the clinic all screening tests are initiated, and if surgery is contemplated direct testing techniques are considered. Direct methods involve invasive procedures and therefore their use is somewhat restricted. In seriously involved vascular disorders and during vascular surgery, angiography and invasive electromagnetic flowmetry are used. The primary burden of a vascular testing technique, which is to be used repeatedly, is that it must be noninvasive in character. However, whether direct or indirect, correlation of test results with the patient's clinical course is extremely important.

1. Square Wave Electromagnetic Flowmetry

Over a period of 10 years our clinical application of the square wave electromagnetic flowmeter (4,5) has enabled us to evaluate mean flow rates and pulsatile blood flow patterns in the peripheral arterial system of patients with peripheral vascular disease. The squarewave EMF provides an immediate, quantitative, accurate method of measuring mean blood flow and pulsatile blood flow intraoperatively before and after
reconstructive surgery and before the patient is released from the operating room. The invasive EMF provides a means for measurement of blood flow in surgically exposed but intact arteries and veins. A flow probe produces a magnetic field across the intact vessel. Blood flow through the field generates an electrical current proportional to the quantity of the blood. A typical pulsatile arterial waveform (Fig. 1) will show a rapid acceleration phase, a slower deceleration phase, and a reverse flow component depending upon the vessel. Mean blood flow appears as a digital readout on the flowmeter.

![Pulsatile Arterial Waveform Diagram](image)

**Figure 1.**—A typical pulsatile arterial waveform.

To illustrate the use of this technique, the following study is presented. A 46-year-old man experienced claudication in his left leg and coldness of his left foot 3 days after a fall in which he struck his left buttock and hip. Marked ischemia of the leg and foot with superficial gangrene of the left great toe soon became evident and femoral, pop-
literate, and pedal pulses were completely absent on this side. A translumbar aortogram showed occlusion of the left common iliac artery. Thromboendarterectomy of the left common iliac artery, left lumbar sympathectomy, and electromagnetic flowmetry were done. The pain in the foot disappeared, the foot and leg became warm, and pulsations were restored to the left femoral and popliteal arteries. The superficial gangrene disappeared and the patient remained asymptomatic 7 years later. Quantification of the flow patterns (Fig. 2) for the left external iliac artery showed changes in the descriptors of the waveform after endarterectomy and lumbar sympathectomy. Mean blood flow increased from 94 ml. per min. to 252 ml. per min after thromboendarterectomy, and further increase to 394 ml. per min. after lumbar sympathectomy. Prior to thromboendarterectomy, the flow tracing for the left external iliac artery showed low amplitude, prolonged and irregular flow acceleration, and deceleration patterns. The irregular flow trace indicated proximal as well as distal occlusion. Immediately following thromboendarterectomy, flow acceleration and peak amplitude increased with the pattern showing a sharply rising peak and relatively smooth trace. The deceleration portion of the trace continued to be prolonged indicating distal peripheral arteriosclerotic involvement. After lumbar sympathectomy the flow trace showed further improvement in these parameters.

**Figure 2.**—Pulsatile waveforms for left external iliac artery before and after thromboendarterectomy and lumbar sympathectomy.

There are several noninvasive techniques now in use in our clinic to determine peripheral vascular involvement: 1. palpation of arterial
pulses, 2. peripheral blood pressure determination, 3. limb temperature profile, 4. Ultrasonic Doppler Flowmetry, 5. Electrical Impedance Plethysmography, 6. Noninvasive Electromagnetic Flowmetry, and 7. Peripheral Pulse Timing. The initial vascular screening techniques are designed to rapidly and quantifiably determine the adequacy of the peripheral circulation. Systolic blood pressures are determined bilaterally by an inflatable cuff and ultrasound detection system for the upper arm, forearm, thigh, and ankle at rest and after a period of exercise. Ultrasonic Doppler Flowmetry is used to ascertain the relative quality of arterial flow velocity at various locations on the extremities. The claudication evaluation determines the time and distance of the onset of leg pain after walking. Tests of programed exercise (extension/flexion) are employed to yield a quantifiable and repeatable value for claudication.

2. Blood Velocity Detection or Doppler Ultrasonic Flowmetry

Blood velocity detection or Doppler Ultrasonic Flowmetry (6,7) is particularly useful for detecting blood flow in severely diseased vessels. Flow can be detected when peripheral pulses are no longer palpable. In principle the device utilizes ultrasound energy which is focused into the moving blood stream. A portion of the transmitted energy is reflected from the moving blood. The reflected frequency varies depending upon the blood flow velocity; a signal representing pulsatile blood flow is obtained. The directional Doppler determines forward and backward blood flow components.

3. Electrical Impedance Plethysmography

When screening tests confirm some degree of vascular involvement, a more detailed noninvasive evaluation is done. A very important technique in this category is electrical impedance plethysmography (8,9). This technique utilizes the concept of a limb segment as a volume conductor of high frequency electrical current. Measurement of impedance fluctuations can be interpreted as volume changes due to arterial pulsations. Quantification of the amount and quality of these pulsations can be related to the status of the vasculature.

Analysis of the electrical impedance waveform (Fig. 3) for eight waveform parameters is obtained by means of a computer. Analog data is fed directly to the computer (PDP-8) or else recorded on magnetic tape for subsequent computer analysis. Impedance measurements are obtained at several segmental locations before and after exercise. A 52-year-old man with bilateral arteriosclerotic involvement complained of pain while walking; however, the pain was greater in the right leg. During his clinical evaluation, pressure gradients were determined (wrist-ankle) bilaterally with no gradient present at rest. Systolic blood
pressure was 148 mm Hg in ankles and wrists at rest. The impedance plethysmographic wave forms for the thigh to ankle segment bilaterally showed a different pattern for the right segment as compared to the left segment indicating greater involvement in the right segment (Fig. 4). This is indicated in the printout especially for acceleration, acceleration time, and peak amplitude with increased acceleration (2.35) and a peak height (126.3) and decreased deceleration time (90) for the left leg as compared to right acceleration (1.93) and peak height (116.8). Further changes in the waveform were evident immediately following exercise. The computerized quantification of the impedance waveform pattern reflects the apparent visual changes.

4. Noninvasive Electromagnetic Flowmetry

During the past 18 months, the Surgical Research Service has been using a new noninvasive electromagnetic blood flowmeter (10) which measures blood flow in peripheral vessels (Fig. 5).

In principle, a moving conductive fluid (blood) generates an electrical potential perpendicular to both the magnetic field and the direction of flow. The magnetic field is generated by a large permanent magnet exterior to the body. Skin electrodes detect voltages which are proportional to the quantity of the flowing blood. Data is processed to disting-
A 65-year-old man complained of claudication of several years duration with greater pain in the left leg than in the right. A bilateral femoral arteriogram showed bilateral arteriosclerotic disease. The involvement was limited to the popliteal arteries and was particularly severe in the left posterior tibial artery. Noninvasive EMF flow patterns were obtained with electrodes positioned at four sites each 2 in. apart over the left popliteal artery (Fig. 6). Evidence of the involvement was seen by disappearance of pulsatile flow in the area of the left posterior tibial artery (D). This confirmed the arteriographic findings (Fig. 7). Good correlation has been obtained by comparing the pre- and post-reconstructive vascular surgery blood flows with measurements obtained during the operation using the invasive electromagnetic flowmeter.
5. Thermistor-Thermometry and Liquid Crystal Thermography

The observation of skin surface temperature of the limbs provides very useful information with respect to blood flow (11,12). The surface temperature of a limb approaches that of its environment when circulation is arrested. The thermistor-thermometer is a useful device for detecting surface temperature. Thermistors are taped to the skin surface at different sites and a direct temperature readout is obtained. All temperatures are recorded with respect to room temperature and forehead temperature. Liquid crystal thermography is a simple, accurate, reproducible, and practical method for detecting and monitoring surface temperature of ischemic limbs. Liquid crystal thermography and thermistor-thermometry determinations are correlated with blood flowmetry measurements before and after surgical procedures. This technique is especially useful in determining level for amputation.

A 52-year-old man with known peripheral arterial occlusive disease was readmitted to Castle Point in 1970. Peripheral vascular disease had been diagnosed in 1964. In 1966 a bilateral lumbar sympathectomy and a right above-knee amputation because of gangrene were done. He was rehospitalized in 1970 with a complaint of redness, swelling, and pain in
the left foot. Exploration of the left femoral artery and intraoperative arteriography were done. None of the major branches of the femoral artery was visualized and only a streak of dye could be seen in the posterior tibial artery. A Dacron graft was inserted. The patient showed some improvement and gangrene was localized to the big toe. Postoperatively the pain in the foot continued and amputation was considered. Prior to amputation, skin surface temperatures were determined using liquid crystal tape with a resultant decision for a Syme amputation. The patient did well postoperatively with good healing of the wound. He was given therapy for prosthesis walking, and 7 months postamputation the patient left the hospital in satisfactory condition. Plans were made to follow him as an outpatient but soon after discharge the patient died of a heart attack.

**Figure 6.—Noninvasive Electromagnetic Blood Flow Study.**
Pulse waves are detected using Photoplethysmograph detectors located in several peripheral sites. Simultaneous bilateral peripheral pulse transmission times are determined relative to the R wave of the electrocardiogram. The pulse wave velocity and transmission time is dependent on cardiovascular properties and is modified by arteriosclerosis and vascular stenoses. Peripheral pulsations were obtained bilaterally for a 44-year-old man who had sustained a traumatic right below-knee amputation 21 years prior to the test. He had been fitted with a prosthesis but had now begun to manifest signs of vascular disease in the stump. Peripheral pulsations were compared with respect to the onset of the R-wave of the ECG for the right and left radial and right and left femoral arteries (Fig. 9). Identical times were obtained for the right and left radial arteries and the left femoral artery (150 ms.). However, transmission time in the diseased right femoral artery (240 ms.) was increased by 90 ms. compared to the time for the left femoral artery. Angiography confirmed this finding and showed occlusion of the right iliac artery.
Principles of Pulse Wave Transmission Time Analysis.

1. Simultaneous bilateral peripheral pulse transmission times are determined relative to the R wave of the electrocardiogram.

2. Pulse waves are detected using Photoplethysmograph detectors located in several peripheral sites.

3. The pulse wave velocity and transmission time is dependent on cardiovascular properties and is modified by Arteriosclerosis and vascular stenoses.

Figure 8.—Peripheral Pulse Transmission Time.

Figure 9.—Peripheral Pulse Transmission Time Study.
1. Development of Arteriosclerotic Disease in Stump of Amputated Limb

A 43-year-old veteran, who served in the U.S. Army from 1952 to 1954, sustained a traumatic below-knee amputation during this period of service and before leaving the service he was fitted with a prosthesis (thigh corset type) which was held in place with straps that were somewhat constrictive. When evaluated in our clinic, the patient stated that he had been able to walk with this prosthesis for 18 years. However, in 1959, he had been treated for cellulitis of the lateral aspect of the right below-knee amputation stump and again in 1972 he was treated for stump pain secondary to a bony spur on the right leg at which time revision of the amputation stump was also done. From November 1972 to January 1973 he had visited the outpatient prosthetic clinic and was fitted with a new prosthesis. On May 13, 1973, he complained that he could not tolerate the socket, and an open ulcer had appeared in the stump scar. The ulcer was treated and appeared to be healing. Numerous visits were made to prosthetic and orthopedic clinics for adjustments to the prosthesis. By July 1973, the patient had not been able to wear his prosthesis for 9 weeks and the pain he was experiencing kept him awake at night. By August 1973, at another clinic, it was found that the femoral and popliteal pulses were absent on the right side. The skin temperature of the amputation stump was reduced and the distal 2 in. were especially cold. Diagnosis was recorded as below-knee amputation, right, with peripheral vascular disease causing an ischemic ulcer on the end of the stump. The patient was advised to discard the prosthesis temporarily, to stop smoking, to take supplemental vitamins, and to do Buerger’s exercises. By November 1973, a crust had formed on the lesion and it was suggested that the patient have the prosthesis checked. In April 1974, the patient found he still could not wear the leg because the stump became irritated after 1 hour when wearing the prosthesis. At this time the patient was referred to our clinic. Decreased circulation to the stump scar was evidenced by the bluish tinge of the tissue. A temperature study confirmed the decreased skin temperature of the thigh. A bilateral arteriogram showed severe arteriosclerotic involvement of the right iliac and femoral arteries. The left side was found essentially normal. A right lumbar sympathectomy was done with resultant improvement in the skin temperature of the stump and color of the scar tissue and disappearance of the pain. The patient has now resumed use of his prosthesis.

This case study emphasizes the particular need to evaluate the status of the vasculature of the amputation stump as well as of the remaining limb. Perhaps all too frequently the prosthetic device receives the greater attention and concern. In the case of this patient, because of the total absence of involvement of the remaining limb, the constrictive nature of
the prosthesis worn by this patient might be considered as a contributing factor to the development of arteriosclerosis in the amputation stump.

2. Prevention of Amputation (13,14)

At the age of 63 years, a known diabetic with generalized arteriosclerosis was admitted because of a painful infection and gangrene of the right foot of 1-month duration. Prior to this admission to Castle Point VAH, the patient had been hospitalized at another institution because of impending diabetic coma and the gangrene of the fourth and fifth toes of the right foot. The gangrene of the toes did not improve with conservative treatment, and amputation of the foot was advised. The patient refused this choice and was brought to Castle Point for further treatment. On admission, examination found gangrene of the fourth and fifth toes of the right foot (Fig. 10) with a denuded ulcer at the dorsum of the foot through the metatarsal area. One week following his admission, a right lumbar sympathectomy was done. The postoperative course was uneventful. The right foot was soaked daily, and 3 months postoperatively a small skin graft was applied. Gradually the wound healed (Fig. 11), and 6 months after the lumbar sympathectomy the patient was discharged to be followed in the clinic. Five years post right lumbar sympathectomy the patient continues to have good skin surface temperatures for the right foot; there is no pain and no gangrene. He ambulates well and is totally self-sufficient.

A 44-year-old diabetic male was hospitalized with bilateral plantar calluses and an ulcer on the right foot. At this time with appropriate control of the patient's diabetes and conservative treatment of the calluses and ulcer he was discharged to be followed in the clinic where he visited sporadically for a period of 1 year. Subsequently, he was readmitted for an ulcerating lesion of the planter surface of the left foot; his diabetes was again uncontrolled. This time a bilateral femoral arterio-
gram showed well opacified femoral arteries and good run-off to the ankles. Following 3 months of conservative treatment, the patient consented to a left lumbar sympathectomy following which, the ulcerating lesion of the left foot showed decided improvement; however, he refused a right lumbar sympathectomy. Approximately 1 year later he was rehospitalized with impending gangrene of the right great toe. He consented to the right lumbar sympathectomy and the impending gangrene disappeared. Further treatment has been necessary for the right foot, i.e., pinch graft with slow but steady improvement. Following right lumbar sympathectomy and with strict dietary control and administration of insulin, the patient's chances of retaining full use of his feet are good.

A translumbar aortogram of an 85-year-old man showed complete blockage of the right aorto-iliac femoro-popliteal system. The patient complained of rest pain and impending gangrene was evident in the right lower limb. Initially a right lumbar sympathectomy was done, but no change in the skin temperature of the right foot was evident. This lack of improvement in surface temperature following the sympathectomy was attributed to the fact that the circulation to the limb was blocked. Thromboendarterectomy of the right profunda femoris artery and insertion of an axillo-femoral bypass were done (Fig. 12). Good pulsatile blood flow was observed in the vessels of the limb. The foot became warm and the higher temperature of the foot as compared to the thigh temperature indicated the effect of the lumbar sympathectomy. The impending gangrene and rest pain disappeared. The combined use

![Figure 12 — Axillo-femoral bypass graft](image-url)

98
of lumbar sympathectomy plus the axillo-femoral bypass graft which was inserted subcutaneously prevented an impending amputation for this geriatric patient and provided him with the viable limb.

A 75-year-old male with diabetes and peripheral arterial occlusive disease complained of intermittent claudication in the right lower limb. Since an arteriogram showed blockage of the right femoral artery, a right lumbar sympathectomy and right femoral endarterectomy were done. Two years later as the disease progressed, the patient returned with gangrene of the right second toe (Fig. 13). A translumbar aortogram showed unilateral occlusive disease with severe involvement for the right lower limbs. Because of the patient's age, presence of ASHD, and diabetes, a subcutaneous crossover femoro-femoral graft was selected (Fig. 14) for this patient. The gangrene was arrested following insertion of the graft, and the toe gradually regained a normal appearance (Fig. 15).
Several important aspects of patient care should be emphasized; i.e., followup and regularly scheduled visits to the vascular clinic are essential. The patient’s interest in his well-being must be maintained, whereas the physician is afforded the advantage of correlating clinic visits and observations with prior treatment and evaluation. At the same time the progressive changes are more easily detected and earlier corrective or palliative measures can be instituted. Once an amputation is done, continued evaluation of the remaining limb is essential in order to maintain this limb.

3. Level of Amputation

Because of years of nonattendance in the vascular clinic, a 79-year-old male was eventually hospitalized for an infected big toe of the left foot. At this time ASHD and PVD with segmental occlusion of the left superficial femoral artery were determined. A femoro-popliteal bypass graft and excision of the left great toe nail were done. The patient did well for 3 weeks, when pain and infection in the toe returned. At this time amputation was considered. Prior to the amputation, electrical impedance plethysmography and temperature studies were done bilaterally for above- and below-knee segments. Good impedance waveforms were obtained for the right side with absence of waveforms for the left
below-knee segment (Fig. 16). No temperature gradient was observed between above and below knee on the right side, whereas a 2.25 deg. C. difference between above knee and below knee was determined for the left limb. Because of these findings for the below-knee segment and the patient's age and involvement an above-knee amputation was done.

**Figure 16.—Impedance Plethysmography for determination of amputation level.**

**NUMBER OF AMPUTATIONS**

In reviewing our surgical service records for the past 15 years, a total of 494 vascular procedures were recorded for a total of 276 patients (Table 1). These procedures were recorded under three categories: 1. lumbar sympathectomy, 2. direct arterial procedure, and 3. amputation. Three hundred and twenty-one sympathectomies, 91 direct arterial procedures, and 82 amputations were completed. Sixty-three of the 276 patients received one or more amputations at some time within the period reviewed.

During 1960-64, 43 vascular procedures were done of which 51 percent were amputations. During 1965-69, 180 vascular procedures were done of which 17 percent were amputations. In 1970-74, 271 vascular procedures were done of which 11 percent were amputation. Thus, there has been a steady increase in the numbers of vascular patients.
**Table 1.**—*Number Vascular Procedures Five-Year Intervals (Percent of Total)*

<table>
<thead>
<tr>
<th>Interval</th>
<th>Lumbar sympathectomy</th>
<th>Direct Arterial procedure</th>
<th>Amputation</th>
<th>Total procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-1964</td>
<td>16 (37)</td>
<td>5 (12)</td>
<td>22 (51)</td>
<td>43</td>
</tr>
<tr>
<td>1965-1969</td>
<td>125 (69)</td>
<td>25 (14)</td>
<td>30 (17)</td>
<td>180</td>
</tr>
<tr>
<td>1970-1974</td>
<td>180 (67)</td>
<td>61 (22)</td>
<td>30 (11)</td>
<td>271</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>321 (65)</strong></td>
<td><strong>91 (18)</strong></td>
<td><strong>82 (17)</strong></td>
<td><strong>494</strong></td>
</tr>
</tbody>
</table>

**Table 2.**—*Above Knee, Below-Knee and Distal Amputations (Percent Total)*

<table>
<thead>
<tr>
<th>Interval</th>
<th>Above Knee</th>
<th>Below Knee</th>
<th>Distal (Syme, Toe)</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>1960-1964</td>
<td>13 (59)</td>
<td>5 (23)</td>
<td>4 (18)</td>
<td>22</td>
</tr>
<tr>
<td>1965-1969</td>
<td>13 (43)</td>
<td>12 (40)</td>
<td>5 (17)</td>
<td>30</td>
</tr>
<tr>
<td>1970-1974</td>
<td>8 (27)</td>
<td>10 (33)</td>
<td>12 (40)</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34 (41)</strong></td>
<td><strong>27 (33)</strong></td>
<td><strong>21 (26)</strong></td>
<td><strong>82</strong></td>
</tr>
</tbody>
</table>
coming to the clinic but a decrease in the numbers of amputee patients has occurred.

Of the total amputations done (82), 34 of these were above knee and 48 represent below-knee and distal (Syme, Toe) amputations (Table 2). Thus, distal amputations represent 59 percent of the amputations done during this 15-year period. It should be noted that during the past 5 years above-knee amputations markedly decreased from 59 percent in 1960-64 to 27 percent in 1970-74. Furthermore, there has been a concomitant increase in distal amputations (Syme, Forefoot, and Toe) from 18 percent in 1960-64 to 40 percent in 1970-74.

CONCLUDING COMMENTS

Theoretically an amputation can be prevented. If methods for detecting early signs of vascular problems, as described, are used, the vascular status of the limbs can be evaluated early and appropriate limb salvaging measures instituted to prevent amputation. If utilized during later stages of the disease, an appropriate evaluation can lead to a decision which might salvage the limb. Multiple evaluations are not readily available; however, in a clinic setting, if appropriately utilized, data should be provided sufficient for determining the critical points at which decisions are made.

With respect to decision making, the several case studies presented represent some of the decisions which can and are made following multiple evaluations. We are acutely aware of the increase in the numbers of persons with peripheral vascular disease, many of whom suffer also from diabetes which adds to the complexity of the problem. Precise methods for assessing vascular status and circulatory reserve and the use of objective methods for evaluation of surgical and medical treatment and the efficacy of long-term followup are emphasized.

REFERENCES